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Corporate Environment, Safety & Health
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LOCKHEED MARTIN

Via Airborne Express
RED0300/014 WBS #42

March 7, 2000

Mr. Gerard J. Thibeault
Executive Officer
California Regional Water Quality Control Board
Santa Ana Region
3737 Main Street, Suite 500
Riverside, California 92501-3339

Dear Mr. Thibeault:

Reference: Former Lockheed Propulsion Company Site
Closure Work Plan Submittal
Regional Board Order No. 94-11

Enclosed are two copies of the Closure Work Plan describing what is anticipated to be the final phase of drilling and ground water sampling activities proposed at the former Lockheed Propulsion Company site (Site). Installation and sampling of five mid-depth and four deep-completion monitoring wells is proposed in this plan. The Closure Workplan is intended to lead to closure of Lockheed Martin responsibility at the Site under Investigative Order 94-11.

This Workplan was developed by considering the results of earlier Lockheed Martin investigation activity at the Site and based on meetings conducted with the Regional Board, most recently in January 1999. In the January 1999 meeting, an understanding was reached between Regional Board Staff and Lockheed Martin on the scope of investigation activities that would be necessary for closure of Order 94-11. It was agreed that provided monitoring results from new wells to be installed at four or five locations near the western boundary of the Site confirmed the absence of site related constituents at levels that pose a risk, the Regional Board would agree that no further action is necessary at the Site. The enclosed Closure Workplan describes the proposed new well locations, construction, sampling plans, and procedures intended to address the Regional Board comments from the January 1999 meeting.

Following completion of the Workplan activities, the results will be evaluated. If the results of characterization activities confirm results from earlier studies, i.e., that conditions are protective of ground water, then a closure report will be submitted. If unanticipated conditions are encountered which may require remediation, the report of results would be accompanied by an Engineering Feasibility Study evaluating potential corrective actions.

Please provide your comments to us regarding the Closure Workplan by May 8, 2000, or, if you are in agreement, your letter of approval allowing activity to proceed according to this plan. If you have any comments or questions, please call me at (818) 847-0791.

Sincerely,

Thomas D. Blackman
Technical Project Manager

CAY:TDB:mg
Enclosure

cc: Douglas Headrick, San Bernardino Valley Water Conservation District
Kevin Mayer, U.S. EPA, Region IX

HSI GEOTRANS
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CLOSURE WORK PLAN
FORMER LOCKHEED PROPULSION COMPANY SITE
REDLANDS, CALIFORNIA

January 20, 2000

Prepared by:

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Reference:

State of California Regional Water Quality Control Board
Investigative Order 94-11

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CLOSURE WORK PLAN
FORMER LOCKHEED PROPULSION COMPANY SITE
REDLANDS, CALIFORNIA

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1.0 INTRODUCTION

Installation and sampling of five mid-depth and four deep completion monitoring wells at the former Lockheed Propulsion Company (LPC) site (the Site) in Redlands, California is addressed in this Work Plan. The well installation and subsequent sampling/evaluation is expected to allow closure of Lockheed Martin Corporation (Lockheed Martin) activity under Regional Board Order 94-11, thus the term "Closure Work Plan" is used for this document. These remaining activities will be implemented in a manner consistent with the requirements under Section 20420 of Title 27 of the CCR for Detection Monitoring Programs, Engineering Feasibility Studies, and where appropriate, Corrective Action Programs. State Water Resources Control Board (SWRCB) Resolution No. 92-49 procedures will also be followed as appropriate.

The work plan includes a background section, objectives, scope of work, work plan tasks, and a tentative implementation schedule.

2.0 BACKGROUND

The former LPC conducted operations at the Site from the early 1960s to early 1970s. Lockheed Martin transferred ownership of the property in the late 1970's. The former LPC Site occupied approximately 495 acres (Figure 1). Currently the property is used for light industrial activities (Seven W Enterprises – 87 acres) and for surface water resource management (San Bernardino Valley Water Conservation District – 409 acres).

Environmental investigations have been conducted on the Site by the California Regional Water Quality Control Board – Santa Ana Region (RWQCB), the Environmental Protection Agency Region IX (EPA), Lockheed Martin and others subsequent to transfer of the property. These investigations have focused on finding trichloroethylene (TCE) at the Site. The "Crafton-Redlands" TCE plume is west of the site approximately three miles from the western property boundary.

None of the Investigations conducted to date have detected TCE in groundwater beneath the Site. The analytical results for these investigations come from sampling of adjacent municipal wells, agricultural wells, and five monitoring wells within the former burn pit area. The burn pit area was originally considered the most likely source area for TCE. Groundwater monitoring wells in this area are screened at various levels from the water table to just above the bedrock surface.

Under Investigation Order No. 94-11 (issued to Lockheed Martin in January 1994) a soil gas investigation was conducted by Lockheed Martin in 1996 (Hydro-Search, 1996). An objective of the soil gas survey program was to determine whether volatile organic compounds (VOCs) were present in the vadose zone at concentrations that would cause future groundwater contamination above MCLs. A combination of

shallow and deep multi-level subsurface soil gas sampling was performed to provide a thorough assessment of the 18 locations that the RWQCB considered high priority potential VOC source areas. The investigation included the installation and sampling of 124 shallow soil vapor probes at thirteen locations throughout the Site. Six deep nested soil vapor wells were also installed in areas considered to have the highest potential for TCE occurrence (other than the former burn pit area, discussed above). Trichloroethlene was detected in soil gas at one deep nested probe location at a maximum concentration of 0.01 parts per million, (Hydro-Search, 1996).

In January 1997 a fate and transport modeling study was conducted to evaluate whether the 0.01 ppm of TCE detected in soil vapor at one location might result in any impact to groundwater beneath the Site (Lorax, 1997). Site conditions were modeled using the SESOIL code for estimating the migration of VOCs in the vadose zone and the AT123D code to estimate the concentrations resulting from chemical loading to the saturated zone for the ensuing 100 year time period. Results of the study showed that if the detected TCE existed throughout a 400'x400'x140' cube of soil beneath the Site that there would be no impact to groundwater. Hypothetical runs were conducted with TCE at one and two orders of magnitude higher concentration than that detected at the Site. The model runs with hypothetical concentrations two orders of magnitude higher than observed showed no groundwater impact above MCL.

An assessment of the potential for TCE to exist beneath the Site as a dense non-aqueous phase liquid (DNAPL) was conducted using available information on the Site in December 1996 (Kueper, 1996). The assessment was conducted by a renown expert in the field of DNAPLs and groundwater hydraulics. The conclusion of the assessment was that DNAPL does not exist beneath the Site.

A work plan was submitted to the RWQCB on February 12, 1997, that proposed the installation of one monitoring well in the area where TCE in soil gas was detected (HSI GeoTrans, 1997). The work plan called for closure of groundwater investigation activity at the Site following implementation of the scope of work and favorable assessment of the results. The RWQCB expressed concern with aspects of the work plan in subsequent phone conversations and the work plan was considered but not approved by the RWQCB in a subsequent meeting in Riverside on January 29, 1999.

The scope of work in this "Closure Work Plan" is submitted with the intent of addressing RWQCB concerns expressed during the January 29, 1999 meeting. After implementation is complete, it is anticipated that no additional Lockheed Martin activity under Order 94-11 will be necessary.

3.0 OBJECTIVES AND SCOPE OF WORK

The objective of this Work Plan is to determine if the former LPC Site is a current source of TCE contamination to groundwater. If results of characterization warrant (e.g., groundwater results far in excess of MCL), remediation could be appropriate. However, based on current information, it is unlikely that TCE will be found at significant concentrations. Thus, implementation of this work plan should allow closure of Lockheed Martin characterization activity. As requested by the RWQCB, new wells will be installed to evaluate water quality in deep groundwater and middle-depth groundwater that occurs beneath the Site.

To achieve these objectives, a field investigation program will be performed. This program will consist of the installation, development, and sampling of up to seven monitoring wells along the west (downgradient) boundary of the Site, and two additional wells in the vicinity of Building 91 at the approximate locations shown on Figure 2. Eight of the new monitoring wells (MW-7A, 7B; MW-8A, 8B; MW-9A, 9B and MW-10A, 10B) will be of a nested design with two wells sharing a common borehole at each of four locations. Within each nest, one well will be screened at approximately the middle of the saturated zone (mid-depth well), and the other well will be screened near the bedrock/alluvium interface (deep well). The remaining well (MW-6) will be a mid-depth completion and installed near existing deep monitoring well MW-4. Together, MW-4 and MW-6 will provide data on groundwater conditions in the mid-depth and deep portions of the saturated zone beneath the northern portion of the Site. Sampling of existing production wells and Site monitoring wells will also be incorporated into the field program.

This program will be conducted in a manner reflective of the requirements of Section 20420 of Title 27 of the CCR for detection monitoring programs. Procedures outlined in the State Water Resources Control Board (SWRCB) Resolution No. 92-49, dealing with policies and procedures for investigation and cleanup and abatement of discharges, will be utilized to assure that the submittals and evaluations have the components expected by the RWQCB. The approach allows RWQCB requirements to be met, and it is anticipated that characterization results will allow no further action (Site Closure) to be granted.

4.0 WORK PLAN

To achieve the objectives of this work plan the following subtasks have been developed:

Subtask 1. Access, Siting, Permitting and Logistics
Subtask 2. Monitoring Well Installation and Development
Subtask 3. Water Level Measurements and Groundwater Sampling
Subtask 4. Data Interpretation and Report Preparation

A description of the work to be performed for each of these subtasks is provided in the following sections.

Subtask 1 - Access, Siting, Permitting and Logistics

The monitoring wells will be located on properties owned by Seven W Enterprises (Seven W) and the San Bernardino Valley Water Conservation District (SBVWCD). Access will be coordinated for the well installation and sampling activities with these parties. Approximate locations for the monitoring wells are shown on Figure 2.

Prior to the initiation of the field activities, utility clearance will be performed at the proposed monitoring well locations. In addition, monitoring well permits will be obtained from the San Bernardino County Department of Environmental Health Services (SBDEHS).

The latest version of the LMC Redlands Plume Project Health and Safety Plan (HASP), Quality Assurance Protection Plan (QAPP), and Standard Operating Procedures (SOPs) will be adopted for use on this project. Site-specific requirements or hazards not addressed in the existing documents will be included as an attachment.

Subtask 2 - Monitoring Well Installation and Development

Nine monitoring wells will be installed during this program at the locations shown on Figure 2. Bedrock is anticipated at less than 500 feet bgs at each of the proposed monitoring well locations. Proposed well MW-6, near the MW-4/4P location, will be installed to a depth of approximately 250 feet bgs to assess mid-depth water quality because existing well MW4 provides characterization of groundwater quality near the bedrock/alluvium interface.

Wells will be constructed as nested pairs within a common borehole. One well will be used to monitor deep groundwater quality near the interface between bedrock and alluvium and will be installed to a maximum depth of 500 feet bgs. The second well will be used to monitor mid-depth water quality within the saturated column and will be installed to a maximum depth of 250 feet bgs or one-half the depth of the deep completion. The two wells will be vertically isolated from each other by a bentonite grout seal. The proposed monitoring well design and construction materials are provided in Figure 4. Following installation, the monitoring wells will be developed to remove the effects of the drilling operations and to maximize communication of the well screen with the formation.

The existing production wells, (Mentone Citrus Growers, COR Madeira, COR Agate #2, COR Maguet #2, and COR Lugonia #4), and Site monitoring wells will be used to collect groundwater depth data prior to well installation activities and will also be sampled for groundwater quality. The COR East Lugonia #6 well will also be

monitored for water levels, but may not be available for sampling as it was previously reported by Hydro-Search (1996) as having been vandalized. In addition, Site monitoring well MW-5P cannot be sampled because of a bend in the casing near surface (Hydro-Search, 1996).

The dual-tube reverse-circulation mud-rotary (reverse-circulation) drilling method will be used to create boreholes for monitoring well installations. If undue complications arise during field activity, an alternate drilling method will be applied. In reverse-circulation drilling, drilling fluid is pumped down through the annulus between the drill pipe and formation and cuttings are moved to the surface through the drill pipe (Figure 3).

Lost circulation material (LCM) and additives will be used as necessary during drilling to maintain borehole integrity. If additives or LCMs are used, they will be free of VOCs.

During drilling, cutting samples will be collected at approximately 5-foot intervals. The cuttings will be placed in sample trays, labeled plastic bags, and other appropriate containers for logging purposes and possible geotechnical and laboratory analysis.

Nested wells consisting of two casing strings per borehole will be constructed at each of the proposed locations shown on Figure 2. Figure 4 shows a schematic well construction diagram and target completion details for each well.

Appropriately sized silica sand will be used as a filter pack and will be placed in the annulus and extend 5 feet above the well screen. Two-feet of transition sand will be placed above the filter pack followed by an annular seal consisting of cement-bentonite grout. An annular seal will also be placed between the upper and lower screened zones to prevent vertical mixing of groundwater within the borehole annulus of the nested wells (Figure 4).

Total depths of wells and final well construction design will be based on field conditions encountered. The maximum drilling depth will be 500 feet bgs.

A down-hole geophysical survey consisting of spontaneous potential (SP), short and long normal resistivity, single-point resistivity, guard resistivity, natural gamma ray, deviation and caliper logging will be performed at one location. The geophysical survey will assist in evaluating lithologic, stratigraphic, and hydrogeologic conditions in the vicinity of the Site.

The mid-depth completion in the monitoring well design assumes saturation despite the significant groundwater level fluctuations that may occur during the monitoring period. Based on historic water level data and data collected by HSI GeoTrans, significant water level fluctuations are likely to occur. For design purposes, it is

estimated that groundwater will be encountered at 150 feet bgs. The mid-depth completion is designed to be installed approximately 100 feet below first water.

Based on previous practices and soil and groundwater analyses from existing Site monitoring wells and nearby production wells, drill cuttings and water generated in the northern (undeveloped) portion of the Site will be discharged to the ground. Wastes generated during well installation in developed areas (i.e., paved lots, concrete pads, etc.) will be containerized for off-site disposal.

The proposed monitoring wells will be used for collecting groundwater samples and water level measurements for one year on a quarterly basis. At the end of this period, data will be evaluated and a recommendation will be made regarding future monitoring or petition for well closure.

The procedures for drilling operations, lithologic logging, geologic sampling, monitoring well installation and development, and water level measurements will be performed in accordance with the SOPs. Site health and safety will be maintained in accordance with the current HASP.

Subtask 3 - Water Level Measurements and Groundwater Sampling

Before groundwater sampling activities, the water level will be measured at each new monitoring well and other existing wells. The existing wells include the four Burn Pit area monitoring wells (MW-1, MW-2, MW-4, and MW-5), two Burn Pit piezometers (MW-4p and MW-5p), and five water production wells (Agate #2, COR Madeira, COR Lugonia #4, COR Maguet #2, and Mentone Citrus Growers).

Groundwater samples will be collected from the newly installed and existing Site monitoring wells once per quarter for 1 year (except for well W-5P, which cannot be sampled). Groundwater samples will also be collected from the Agate #2, Mentone Citrus Growers, COR Madeira, COR Lugonia #4 and COR Maguet #2 wells if available. The groundwater samples will be analyzed for VOC, using EPA Method 8010 and for perchlorate by EPA Method 300 Modified.

The procedures for measuring water levels and field water quality parameters and collecting groundwater samples from the monitoring wells will be performed in accordance with the existing HSI GeoTrans project SOPs.

Subtask 4 - Data Interpretation and Report Preparation

Following completion of the well installation program a brief report will be prepared. The report will contain the following:

- A summary of field methods and findings;
- Soil borehole logs and monitoring well construction logs for the newly installed monitoring wells; and
- Associated appendicized materials.

Subsequent quarterly groundwater monitoring reports will be prepared. The brief letter-style reports will contain the following:

- Summary of field methods and findings;
- Tabulated analytical data in a cumulative format;
- Potentiometric surface map; and
- Appendicized laboratory data sheets, chain-of-custody records and QA/QC sheets.

At the end of the 1-year quarterly monitoring period, results of all field investigation activities will be summarized in a Project Report/Engineering Feasibility Study in accordance with Section 20420, Title 27 CCR and SWRCB Resolution No. 92-49. The report will include the methodologies and investigation findings. Specifically, the report will contain the following:

- A summary of previous investigations;
- A summary of the investigation activities and results;
- A summary of conclusions and site conditions;
- A summary of the analytical groundwater results;
- Potentiometric surface maps for the four previous groundwater sampling events;
- Appendicized data to support the report findings and conclusions;
- Identification of corrective action objectives (if any);
- Identification and evaluation of corrective action alternatives (including no action); and
- A conceptual design/implementation plan for selected alternative.

If the Report of Results/Engineering Feasibility Study concludes no further action, then the report will also include a request to the RWQCB for formal closure of the site as a source of contamination to groundwater.

5.0 SCHEDULE

The proposed schedule to perform the monitoring well installation, development, initial and subsequent quarterly sampling and reporting is presented on Table 1. The schedule is based upon duration (in weeks) following approval of this Work Plan by the RWQCB.

Access and permitting will be initiated upon RWQCB approval of this Work Plan. Approximately 4 weeks will be required to complete the access approval and permitting, provide utility clearance for the monitoring well locations, and schedule drilling activities.

Preparing sites for drilling and well installation will be performed in weeks 5 through 7. Well installation and airlift development will begin in week 7 and continue through week 15.

Pump development and well sampling activities will begin in week 13 and continue through week 16.

A well installation report will be submitted by approximately week 22. Quarterly groundwater monitoring reports will be submitted no later than 30 days following the end of each subsequent quarter. A final closure report is expected to be complete approximately 68 weeks following RWQCB approval.

6.0 REFERENCES

Hydro-Search, Inc., 1995, Phase 1 Work Plan and Schedule Addendum, Investigation of the 1500 Crafton Avenue, Redlands, California Site as a Potential Source Area to the Redlands Groundwater Plume: Submitted to the Regional Water Quality Control Board, Santa Ana Region, dated December 14, 1995.

Hydro-Search, Inc., 1996, Groundwater Sampling from Existing Wells and Vadose Zone Investigation of the 1500 Crafton Avenue, Redlands, California Site as a Potential Source Area to the Redlands Groundwater Plume: Submitted to the Regional Water Quality Control Board, Santa Ana Region, dated December 20, 1996.

Kueper, B.H., 1996, Assessment of DNAPL Presence at the 1500 Crafton Avenue Site: prepared for Lockheed Martin Corporation: submitted to the Regional Water Quality Control Board, Santa Ana Region, dated December 6, 1996.

Lorax Environmental Inc., 1997, Preliminary Fate and Transport Modeling Report, 1500 Crafton Avenue Site, Redlands California Site, Redlands, California: prepared for Lockheed Martin Corporation: submitted to the Regional Water Quality Control Board, Santa Ana Region, dated January 1997.

Richard C. Slade and Associates, 1986, Field Memorandum No. 4, Madeira Well Site Construction, Mentone Area, dated June 7, 1986.

HSI GeoTrans, Inc., 1997, Revised Task 6 Groundwater Investigation Work Plan, 1500 Crafton Avenue, Redlands, California Site as a Potential Source Area to the Redlands Groundwater Plume: submitted to the Regional Water Quality Control Board, Santa Ana Region, dated February 12, 1997.

TABLE

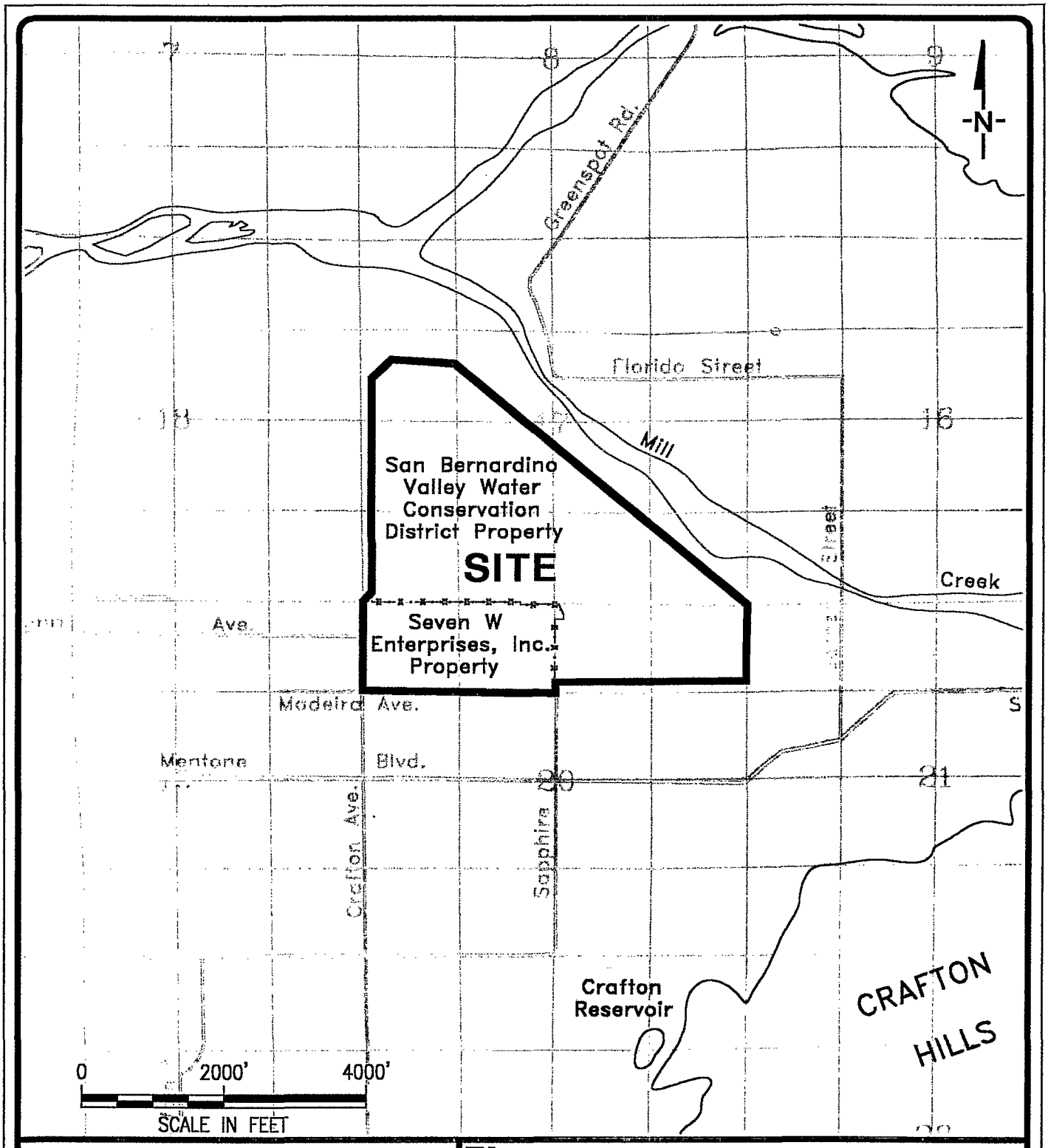
TABLE 1

SCHEDULE FOR MONITORING WELL INSTALLATION, DEVELOPMENT, SAMPLING, AND REPORTING

Activity	Duration (weeks)	[1]Completion Periods (weeks)
Site Inspection & Permitting	4	4
Well Drilling & Installation:		
• Site Grading/Set Conductor Casing	3	7
• Field Mobilization (drill rig)	1	7
• Drill Borings/Install Wells	8	15
• Airlift Development	2	15
• Well Development (pump)	3	16
• Wellhead Completion/Site Restoration	2	16
• Well Installation Reporting	6	22
1st Quarterly Sampling Analysis and Monitoring Reporting	9	25
2nd Quarterly Sampling Analysis and Monitoring Reporting	9	37
3rd Quarterly Sampling Analysis and Monitoring Reporting	9	49
4th Quarterly Sampling Analysis and Monitoring Reporting	9	61
Site Closure Report	7	68

[1] Time period in weeks following RWQCB approval of workplan.

FIGURES



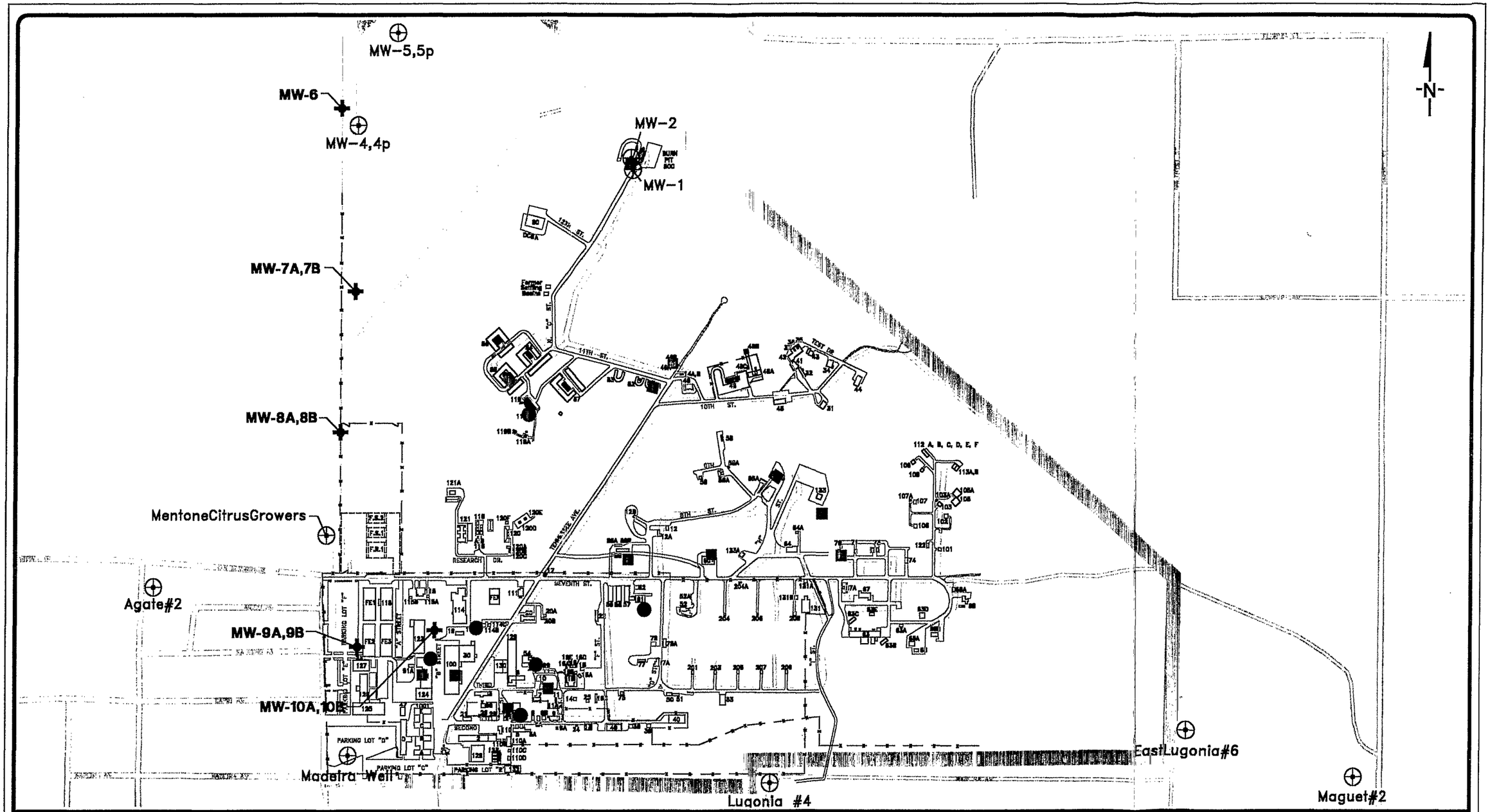
TITLE: Site Location

LOCATION: LOCKHEED MARTIN REDLANDS, CALIFORNIA

HSI GEOTRANS A TETRA TECH COMPANY

CHECKED:	Ian Hattie
DRAFTED:	Hector Magaña
PROJ.:	C590-101
DATE:	05/18/99

FIGURE: 1



EXPLANATION

- Agate#2 — Existing Well/Sampling Location
- MW-7A,7B — Proposed Monitoring Well Location
  - A – Mid-Depth Completion
  - B – Deep Completion
- Soil Gas Survey Location
- Nested Soil Gas Probe Location
- Site Boundary

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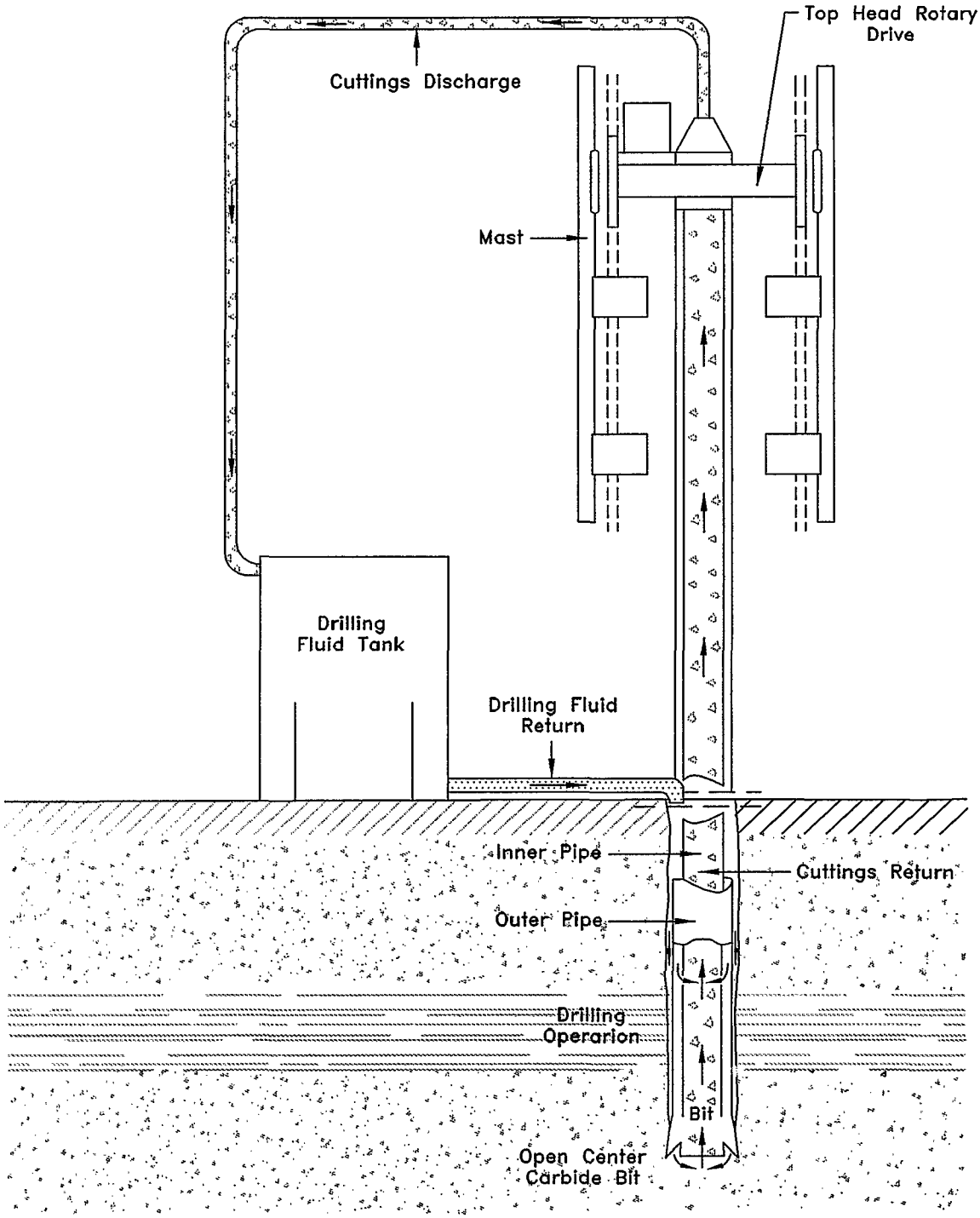
TITLE: Existing and Proposed Well and Vadose Zone Investigation Locations

LOCATION: LOCKHEED MARTIN REDLANDS, CALIFORNIA

HSI GEOTRANS A TETRA TECH COMPANY

CHECKED:	Ian Hattie
DRAFTED:	Hector Magaña
PROJ.:	C590-101
DATE:	05/18/99

FIGURE: 2



TITLE: Fluid Reverse-Circulation Mud-Rotary Drilling Method

LOCATION: LOCKHEED MARTIN REDLANDS, CALIFORNIA

HSI GEOTRANS A TETRA TECH COMPANY

CHECKED:	Roy Marroquin
DRAFTED:	Hector Magaña
PROJ.:	C590-101
DATE:	09/10/97

FIGURE: 3

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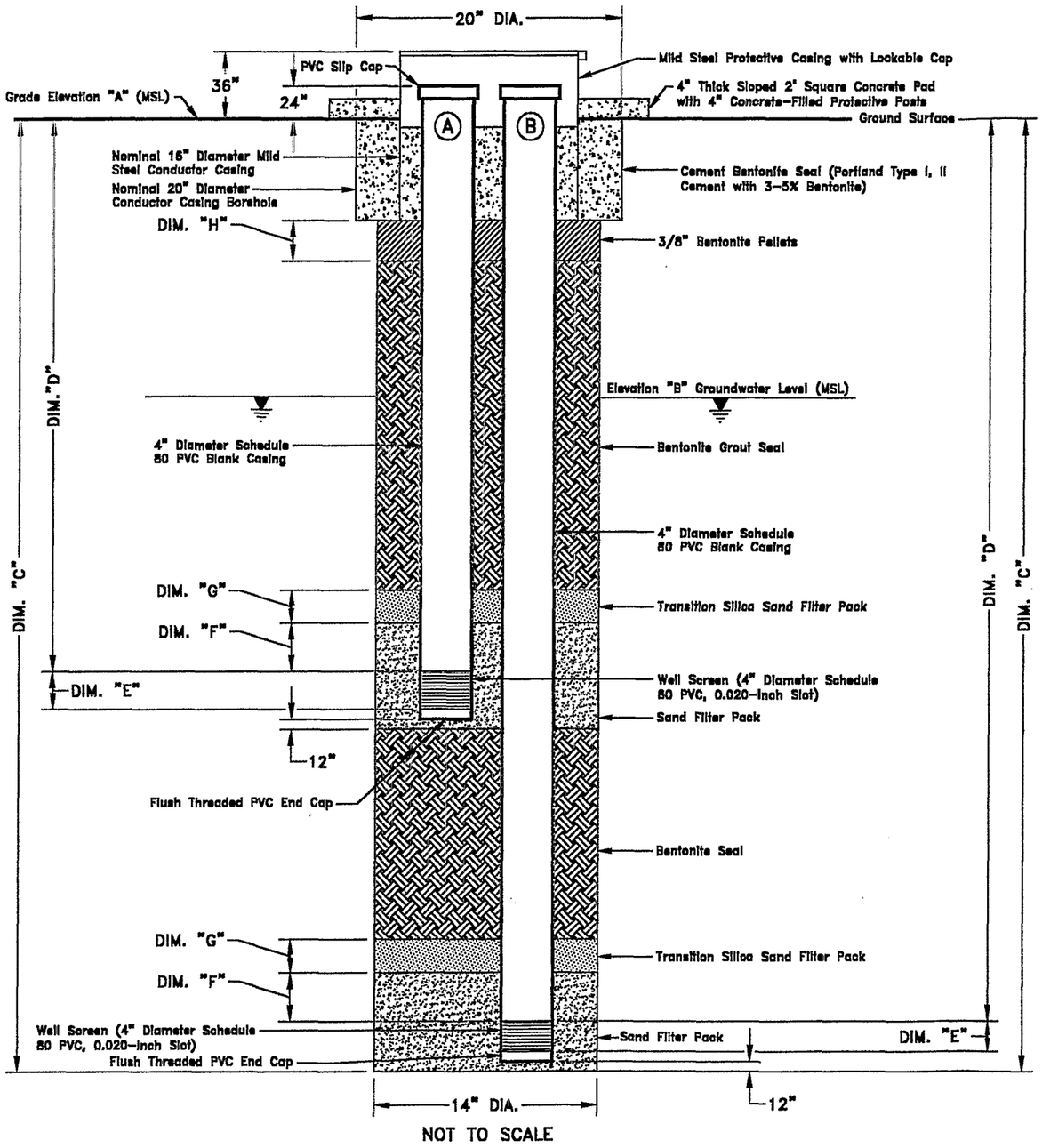

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Well Dimension Schedule									
Well No.	APPROX. ELEV.* "A"	ESTIM. ELEV.* "B"	DIM. "C"	DIM. "D"	DIM. "E"	DIM. "F"	DIM. "G"	DIM. "H"	SAND SIZE[1]
MW-6	1734	1584	501	245	20	5	2	5	8x20
MW-7A	1740	1590	501	245	20	5	2	5	8x20
MW-7B	1740	1590	501	490	10	5	2	5	8x20
MW-8A	1760	1610	501	245	20	5	2	5	8x20
MW-8B	1760	1610	501	490	10	5	2	5	8x20
MW-9A	1765	1615	501	245	20	5	2	5	8x20
MW-9B	1765	1615	501	490	10	5	2	5	8x20
MW-10A	1770	1620	501	245	20	5	2	5	8x20
MW-10B	1770	1620	501	490	10	5	2	5	8x20

* Approximate elevation relative to mean sea level (MSL)

[1] Refers to gravel pack sand size

NOTES:

1. DIM. "C" borehole depth from grade (FT.).
2. DIM. "D" blank casing depth from grade (FT.).
3. DIM. "E" length of well screen (FT.).
4. DIM. "F" filter sand thickness above top of screen.
5. DIM. "G" transition sand thickness above filter sand.
6. DIM. "H" bentonite pellet seal (FT.). Pellets shall be 3/8" diameter.
7. Cement/bentonite grout seal shall be finished 6" below grade.
8. Filter pack sand shall be a well rounded siliceous kiln dried, fresh water washed sand.
9. Sand size are specified in U.S. standard mesh. Transition sand shall be 30 mesh.
10. Cement/bentonite grout seal shall not exceed 5% bentonite.
11. Well casing shall be trimmed level 24" above grade.
12. Screen slot sizes are specified in inches.
13. All annular materials to be introduced by tremmie pipe.
14. Surface completion may be flush mounted with traffic-ready vault and water-tight lockable cap. Above-ground completions shall include four concrete-filled steel posts.
15. Well construction design subject to change.

TITLE: Proposed Monitoring Well Construction

LOCATION: LOCKHEED MARTIN REDLANDS, CALIFORNIA

HSI GEOTRANS A TETRA TECH COMPANY

CHECKED:	Ian Hattle
DRAFTED:	Hector Magaña
PROJ.:	C590-101
DATE:	6/17/99

FIGURE: 4